Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A10A0085

COLLISION WITH WATER

CESSNA 414A, C-GENG
SYDNEY, NOVA SCOTIA, 13 nm EAST-NORTHEAST
05 AUGUST 2010

Canada

Aviation Investigation Report

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Synopsis

The privately owned Cessna 414A (registration C-GENG, serial number 414A0288) departed Toronto/Buttonville Municipal Airport, Ontario, en route to Sydney, Nova Scotia. The flight was operating under an instrument flight rules flight plan with the pilot-in-command and the aircraft owner on board. Nearing Sydney, the aircraft was cleared to conduct an instrument approach. At the final approach waypoint the pilot was advised to discontinue the approach due to conflicting traffic. While manoeuvring for a second approach, the aircraft departed from controlled flight, entered a rapid descent and impacted the water at 2335 Atlantic Daylight Time. The aircraft wreckage was located using a side-scan sonar 11 days later, in 170 feet of water. The aircraft had been destroyed and both occupants were fatally injured. No signal was detected from the emergency locator transmitter.

Ce rapport est également disponible en français.

Other Factual Information

History of the Flight

The owner had recently purchased the occurrence aircraft and on the day of the accident was taking possession of it at the Toronto/Buttonville Municipal Airport. The owner did not have any pilot-in-command (PIC) [1] multi-engine experience, and consequently the insurance company required a more experienced pilot to fly the aircraft with him for 20 hours. The owner had engaged a pilot with Cessna 340 experience and some multi-engine hours to act as PIC. The PIC had not flown a Cessna 414 before.

Once a private pilot receives a multi-engine rating, the blanket rating qualifies the pilot to fly any multi-engine aircraft that is non high performance. [2]

At Buttonville, the PIC obtained 1.5 hours of ground familiarization training with a check pilot familiar with the Cessna 414A. This training was conducted inside the aircraft, without air conditioning and with an outside air temperature exceeding 30°C in high humidity. A 1 hour flight with the check pilot was then completed with the owner seated in the rear of the aircraft; air conditioning was available during this flight. The flight was conducted in visual flight rules (VFR) weather with light to moderate turbulence. The training consisted of steep turns, slow flight, and autopilot work. Aerodynamic stalls were not practiced due to turbulence. There were no aircraft deficiencies reported during the flight.

Following the familiarization training, the PIC and owner departed the Toronto/Buttonville Municipal Airport at 1930 [3] (1830 local time) on an instrument flight rules (IFR) flight to Sydney. All historic technical logs and other aircraft documents were placed on board the occurrence aircraft before the departure from Buttonville. The flight continued uneventfully until nearing the Sydney J.A. Douglas McCurdy Airport. The aircraft was maintaining 4000 feet above sea level (asl) and was cleared by Moncton Area Control Centre (ACC) for the RNAV (GNSS) [4] Runway 25 approach via the OBVUP initial waypoint (see Appendix A).

All radio communications during the RNAV approach were made by the PIC. At 2324 Moncton ACC cancelled the approach clearance and advised the aircraft to expect a hold at the final approach waypoint (EBLUG) due to a commercial aircraft landing on Runway 07, and to slow down to try and avoid the hold. The aircraft did not reduce speed. About 1 minute later the aircraft was again asked to reduce speed to avoid the hold and again the aircraft did not reduce

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1 As defined in the *Aeronautics Act*, section 3(1), "pilot-in-command means, in relation to an aircraft, the pilot having responsibility and authority for the operation and safety of the aircraft during flight time."

2 High performance aeroplane - an aeroplane requiring only one pilot and having a never exceed speed (VNE) of 250 knots or greater, or a stall speed (VSO) of 80 knots or greater.

3 All times are Atlantic Daylight Time (Coordinated Universal Time minus 3 hours).

4 Instrument approach based on area navigation (RNAV) using a global navigation satellite system (GNSS).

speed. At 2326:45, Moncton ACC instructed the aircraft to turn right (north) and proceed back to the OBVUP due to the landing traffic. The aircraft turned left (south).

After the aircraft turned left the flight path became erratic (see Figure 1). The aircraft changed heading numerous times with altitude deviations of up to 500 feet, which was consistent with the aircraft being flown manually (possibly while the GPS was being reprogrammed). During this period the airspeed did not substantially change. This erratic flight path continued for more than 4 minutes during which radio communications were maintained with both Moncton ACC and Charlottetown Radio. [5]

Figure 1. Aircraft flight path

At 2328:00 Moncton ACC offered the aircraft the RNAV (GNSS) Runway 25 approach via the south initial waypoint (LERES) and instructed the aircraft to descend to 3000 feet asl. The pilot acknowledged the offer but declined to conduct the approach from the south; the aircraft did not descend. At 2329:06, after the other aircraft had landed and cleared the runway, Moncton ACC again instructed the pilot to descend to 3000 feet asl. Again the pilot acknowledged the instructions; however, the aircraft did not descend.

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5 Charlottetown Radio is the remote communications outlet for the Sydney Airport.

The pilot was then re-cleared for the RNAV (GNSS) Runway 25 approach via the OBVUP, but there was no response from the pilot. At 2329:40, Moncton ACC again contacted the pilot to clear him for the RNAV approach; the PIC responded using the registration call sign of his personal aircraft. At 2333:00 the aircraft was observed on radar to be proceeding direct toward OBVUP.

At 2333:09 Moncton ACC offered the PIC radar vectors to either Runway 25 or 07. The pilot declined and advised that they were re-established direct OBVUP. The aircraft altitude and heading were maintained, which is consistent with the autopilot being engaged. The aircraft's track to OBVUP created a closing angle of approximately 130° with the course OBVUP-GAGBU. Moncton ACC advised the pilot to request radar vectors if he preferred, and to contact Charlottetown Radio. At 2334:37 the pilot contacted Charlottetown Radio at which time he received the local weather conditions. This was the last radio communication from the aircraft. At 2335:36 the aircraft was observed on radar entering a right turn, then descending rapidly. The aircraft struck the water in a near vertical attitude at high speed. [6]

The Pilot-in-Command

The PIC began his flight training in 2000 and held a private pilot licence with a multi-engine and a Group 1 IFR rating. The IFR rating was renewed on 07 June 2009. He held a category 1 medical issued in March of 2010 at which time he recorded on the medical form he had 530 hours of total flight time, 100 hours in the last 12 months. The PIC attended mountain ground school in May of 2002 and 'rusty wings' ground school in March 2003. Both ground schools were offered at the Calgary flying club and included human factors and pilot decision-making training. In December 2007 he attended a commercial licence ground school which included crew resource management, minimum equipment list and controlled flight into terrain avoidance training. In September of 2009 he had completed 21 hours of flight training towards his commercial licence. He owned a Cessna 340—a light, twin-engine airplane—since 2008. His experience was deemed sufficient by the insurance company to act as the PIC and ferry pilot on the occurrence aircraft.

The PIC's training and experience on the occurrence aircraft and its systems was limited to that received at Buttonville and during the occurrence flight. He was unfamiliar with the GPS units installed on the aircraft and had never flown into the Sydney Airport. The PIC preferred not to fly in inclement weather or at night. When flying with another pilot he would often let the other pilot fly the aircraft.

Aircraft Owner

The owner began his flight training in 1993, and held a private pilot licence with a multi-engine rating. He had attended a commercial license ground school in October 2003 which included human factors and pilot decision making. His multi-engine experience was limited to 15 hours of twin engine instruction prior to August 2008. He held a category 3 medical issued in March 2010 at which time he recorded on the medical form he had 460 hours of total flight time,

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[6] Radar data indicates a rate of descent about 10 000 feet per minute.

50 hours in the last 12 months. He recorded 25 hours of hood instrument training up until February 2010, and 6.7 hours of simulator training from 02 to 22 June 2010.

The owner did not receive any training on the occurrence aircraft or its systems. He owned a single-engine airplane, a Cessna 182, since 2003, and had previously flown into the Sydney airport a few times, but only during daylight hours. When flying with other pilots, the owner preferred to be the pilot flying the aircraft, particularly if it was his own.

Crew Activities

In the days preceding the occurrence the PIC and owner had not conducted any activity outside of their normal routines.

On the morning of the occurrence, the PIC and the owner left Calgary, Alberta, at 1000 (0700 local time) on a commercial flight and arrived in Toronto, Ontario, at approximately 1340 (1240 local time). Based on a conservative estimate of the commuting time to the Calgary airport, plus the required hour of wait between check-in and departure, it is likely that they woke no later than 0800 (0500 local time). At the time of the occurrence, they would have been travelling for more than 15 hours. There are duty day requirements for commercial pilots in the *Canadian Aviation Regulations* (CAR 720.15); however there are no set duty day time requirements for private pilots.

The PIC was the director of a company which was holding a scheduled board meeting in Sydney on 07 August 2010. Other meetings were planned with investors for 06 August 2010 in the Sydney area. The company had purchased tickets on a commercial flight for the PIC but he declined on the basis he was assisting a friend to pick up an aircraft, and would nonetheless be there for the morning of 06 August 2010.

Aircraft Information

The Cessna 414A is a pressurized low-wing twin-engine aircraft with retractable tricycle landing gear (see Photo 1). The occurrence aircraft had a RAM Series IV conversion, which included upgraded engine performance and wing-mounted vortex generators, to increase the performance and useful load of the aircraft. The aircraft was equipped and certified for IFR operation.

Photo 1. Occurrence Aircraft

Two panel-mounted GPSs, a Garmin 430 and a King KLN 90B, were installed for navigation and approved for IFR approaches. A panel-mounted switch could select either GPS to be coupled to the Bendix Autopilot. The Cessna 414A has dual controls and can be flown from either seat.

Records indicate that the aircraft was certified and equipped in accordance with existing regulations. The historic aircraft records were placed aboard the aircraft. Copies of the most recent maintenance completed were retained by the maintenance facilities in Buttonville. These were used to determine that the aircraft had no known deficiencies before the occurrence flight. The combustion-style heater was removed, overhauled and tested serviceable on 27 July 2010. The weight and center of gravity were within prescribed limits at the time of the accident. There was sufficient fuel on board to complete the flight. The aircraft was not equipped with onboard recorders nor were they required by regulation (CAR 605.33). The aircraft was equipped with an Artex model ME-406 emergency locator transmitter (ELT). The ELT was not recovered.

Weather

The weather in the area at the time of the accident was as follows: wind 200° True (T) at 8 knots, visibility 12 statute miles (sm) with a broken ceiling at 700 feet above ground level (agl), overcast ceiling at 15 000 feet agl, temperature 21°C, dew point 20°C and barometric pressure 29.64 inches of mercury. The actual weather was within the PIC's legal requirements for conducting an approach and landing as depicted on the Sydney Canada Air Pilot Instrument Procedures chart. The graphical area forecast did not forecast turbulence in the Atlantic region.

Wreckage Information

There was virtually no wreckage found on the surface of the water. A remotely-operated vehicle recorded images of the wreckage debris which was spread over a relatively small area on the ocean floor at a depth of 170 feet. Wreckage recovered included pieces of wing, fuselage and empennage. The recorded images and the recovered wreckage were examined. There was no indication of an in-flight breakup and it was determined that the engines were operating at the time of impact. The damage was consistent with a high-speed, near vertical impact.

Flying Duties

When two pilots of equal skill and experience are flying together, usually they will share the flying duties; one flies the aircraft while the other operates the radios, enters data into the navigational system and monitors the flying pilot. Although the flying duties may be shared, the designated PIC is responsible for all aspects of the safe operation of the aircraft.

Task Saturation and Spatial Disorientation

All humans are susceptible to spatial disorientation. In aviation, spatial disorientation can be defined as an aviator's failure to sense correctly the position, motion, or attitude of the aircraft or themselves with respect to the earth's surface and the gravitational vertical. Richard Leland, director of the Aeromedical Training Institute, discusses spatial disorientation in an article on which most of the following section is based, and from where the following quotes originate. [7]

In darkness, peripheral visual information (or ambient vision) is reduced. "Ambient vision is sensitive to flat planes (i.e. the horizon) and motion cues, and is processed by the preconscious brain. Under day visual meteorological conditions (VMC), the pilot specifically uses ambient visual information…to judge and maintain proper aircraft attitude."

"At night, much of the ambient visual information is absent. Also, the potential for other visual illusions (false horizon or indistinct horizon) is much higher." Focal vision must be used to maintain aircraft attitude by reading the flight instruments. Focal vision is processed by the conscious brain, and the conscious brain can quickly become overwhelmed. This state is termed task saturation, and can result in important situational awareness cues (i.e., altitude, descent rate) being missed. The pilots most susceptible to task saturation are those who are not trained to operate in limited visibility conditions, those who have been trained but have not flown in similar conditions for a long time, and pilots with limited experience.

Cockpit tasks are more difficult at night. "Switches are harder to find and placards are harder to read under low cockpit lighting conditions. Again, this puts an increased load on the conscious brain and this, in turn, raises the potential for unrecognized spatial disorientation and/or loss of situational awareness."

"Instrument training disciplines the pilot in conscious attention management and helps him avoid attention management problems like channelized attention, distraction, and task saturation. Additionally, instrument training disciplines the pilot to ignore false sensory perceptions and believe the instruments."

According to the Federal Aviation Administration, spatial disorientation and loss of situational awareness cause 15% to 17% of fatal general aviation crashes annually (about 2.5% of the total mishaps). "More significantly, 9 out of 10 spatial disorientation mishaps result in a fatality. Most of these mishaps occur when pilots are flying at night and/or…in instrument meteorological conditions."

A number of factors can predispose a pilot to spatial disorientation during night flying. These factors can be classified into 3 categories: environmental, psychological, and physiological.

> Environmental factors include those factors that reduce the amount of information (usually visual information) that is normally available to the pilot during day, VMC flying conditions. These include: night, IMC, blending of the surface of the water with an overcast sky (for overwater flights), fog, and haze. These factors tend to make the horizon difficult or impossible to distinguish, thus requiring the pilot to revert to the flight instruments in order to maintain level flight.

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7 Richard A. Leland, "Night VFR: An Oxymoron?", *The Journal of Aviation/Aerospace Education and Research*, Vol. 9, No. 1, Fall 1999, Embry Riddle Aeronautical University.

> Psychological factors are those factors that impose an additional processing load in the conscious brain. When these factors are present, the pilot may experience task saturation; a condition where there is more information that must be processed than the conscious brain can handle. This may allow dangerous flight conditions to persist until time to successfully recover is no longer available. Psychological factors may include instrument /navigation flying, low level flying, a contingency situation (such as an in-flight emergency), or visual navigation under degraded visual conditions.
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> Physiological factors are those that degrade the pilot's ability to perform. Unlike the environmental factors and the psychological factors, the pilot can directly influence whether physiological factors are or are not present during flight. By far the most common physiological factor is fatigue. Fatigue impairs concentration; simple tasks become difficult and difficult tasks may become impossible when the pilot is fatigued. [8]

Studies conducted by aviation researchers at the University of Illinois in the 1990s estimated that, on average, it took 178 seconds for VFR pilots exposed to simulated IMC conditions to become spatially disoriented. [9] The studies were described in an article published in *Flight Safety Australia*, which recounts the following:

> They took 20 VFR pilots and got them to fly into instrument meteorological conditions (IMC) in specially programmed flight simulators. All of the pilots in the study went into graveyard spirals that would have ended in uncontrolled flight into terrain or rollercoaster-like oscillations that became so intense that they would have resulted in structural failure of the aircraft.

Spiral Dive

A spiral dive can be defined as a steep descending turn where the aircraft is in an excessively nose-down attitude, and where the airspeed increases rapidly. A pilot can get into a spiral dive by allowing the attitude of the nose to become too low, due to excessive bank while in a steep turn. If an attempt is made to raise the nose, then the spiral tightens and there is a rapid loss of height and an increase in speed. Transport Canada identifies spatial disorientation and the absence of a visible horizon as contributing factors to spiral dives. [10]

Final Minutes of Flight

Once established on the second approach, the aircraft altitude and heading were maintained which is consistent with the autopilot being engaged.

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8 *Ibid.*

9 Paul Cummins and staff writers, "178 Seconds to Live VFR into IMC", *Flight Safety Australia*, January–February 2006.

10 Transport Canada, TP185-4-99-132-4127, Aviation Safety Letter, April 1999.

The aircraft was observed on radar proceeding direct toward OBVUP, then making a 360 degree right turn in about 20 seconds, with radar returns at 4000, 2600 and 1900 feet asl before it was lost off radar. The radar track and the descent rate of the aircraft are indicative of a spiral dive.

The following TSB Laboratory reports were completed:

LP115/2010 – Radar /ATC Synchronization
LP153/2010 - Route Map

Analysis

The two occupants of the aircraft did not survive the accident. There were no witnesses to the final moments of the flight and there were no onboard recording devices to assist investigators. The aircraft impacted the water in a near vertical attitude, suggesting an in-flight loss of control. This analysis therefore focuses on possible scenarios explaining why the aircraft departed controlled flight and collided with the water.

Although the aircraft was extensively damaged by the impact, there was no evidence suggesting a problem with the flight controls or engines. All historic technical records were carried on the occurrence aircraft; only the most recent maintenance records could be reviewed as copies were retained by the facilities in Buttonville. This practice impeded the determination of the aircraft's maintenance history since new. The investigation ruled out turbulence as a factor for loss of control because there were no significant weather conditions in the area that could cause turbulence.

The PIC was communicating on the radio up until 1 minute before the loss of control. During these communications, the PIC did not indicate any medical concerns or display any signs of impairment. This, coupled with the fact that the heater was recently overhauled and tested serviceable just days before the occurrence flight, allowed the investigation to rule out carbon monoxide poisoning. Pilot incapacitation was therefore not considered a contributing factor.

The PIC was in an unfamiliar aircraft, was flying in conditions which he did not like (night, inclement weather), and was operating into an unfamiliar airport. These factors would have contributed to the degradation of the PIC's conscious attention management capability. Simple tasks such as re-programming the GPS would have become difficult and may have taken attention away from flying for several minutes. Important steps were omitted such as reducing the airspeed or changing altitude when repeatedly instructed to do so. Additionally, the pilot turned to the left when instructed to turn right, and declined the offer for radar vectors−which would have reduced pilot workload.

The owner had received limited experience flying a multi-engine aircraft 2 years earlier, had limited instrument flight experience and had not received any training on the occurrence aircraft or its systems. These factors would have contributed to the degradation of the owner's conscious attention management capability.

The aircraft track nearing OBVUP created a sharp closing angle on the OBVUP-GAGBU track. As the aircraft neared the OBVUP waypoint, the course track bar on the GPS would have moved very quickly toward the GAGBU waypoint. Due to the maximum rate of turn that an autopilot system allows, the aircraft would have flown through the OBVUP-GAGBU track before regaining course. To prevent this, a pilot would have to manually take control and initiate a steep turn. In an attempt to intercept the OBVUP-GAGBU course, an inexperienced pilot may try to follow the track bar using an increasingly steep bank angle. If this steep bank angle is left uncorrected, a spiral dive will result.

The PIC and owner started their day in Calgary at 0800 (0500 local) and had been travelling for more than 15 hours. The training in Buttonville was carried out under conditions of high heat and humidity. During the final minutes of the flight, it is likely that the PIC and owner were task saturated. Although fatigue is not supported by any factual information received, the lengthy day may have exacerbated the level of task saturation. When a pilot is task saturated, the increased load on the conscious brain raises the potential for unrecognized spatial disorientation and/or loss of situational awareness. Erratic flying consisting of multiple heading and altitude excursions while the aircraft is flown manually are indications that the pilot was possibly task saturated and disoriented. Spatial disorientation and the absence of a visible horizon have been identified as contributing factors to spiral dives. The radar track and the descent rate of the aircraft were indicative of a spiral dive. It is likely that the PIC and owner were both suffering some degree of spatial disorientation during the final portion of the flight. The crew was unable to recover control of the aircraft before contacting the surface of the water.

The investigation could not determine whether it was the PIC or the owner who was at the controls.

The PIC had arranged for a business meeting in Sydney on the morning of 06 August 2010. Self-imposed pressure to make this appointment likely influenced the crew's decision to depart Buttonville despite:

- their lack of experience on the aircraft type;
- their unfamiliarity with the destination airport;
- the night/IFR conditions; and
- the lengthy day.

Due to the severity of the impact damage, the aircraft likely sank quickly and the ELT would not have transmitted a signal. [11] In 170 feet of water, attenuation would have masked the ELT signal if the ELT had withstood the initial impact.

11 By regulation, the first 406 MHz transmission from the ELT does not occur until about 50 seconds after activation.

Findings as to Causes and Contributing Factors

1. It is likely that the PIC and the owner were both suffering some degree of spatial disorientation during the final portion of the flight. This resulted in a loss of control of the aircraft and the crew was unable to recover prior to contacting the surface of the water.

2. The PIC did not accept assistance in the form of radar vectors, which contributed to the workload during the approach.

3. Self-imposed pressure likely influenced the crew's decision to depart Buttonville despite the flight conditions, lengthy day, and lack of experience with the aircraft and the destination airport.

Other Findings

1. It could not be conclusively determined who was flying the aircraft at the time of the occurrence.

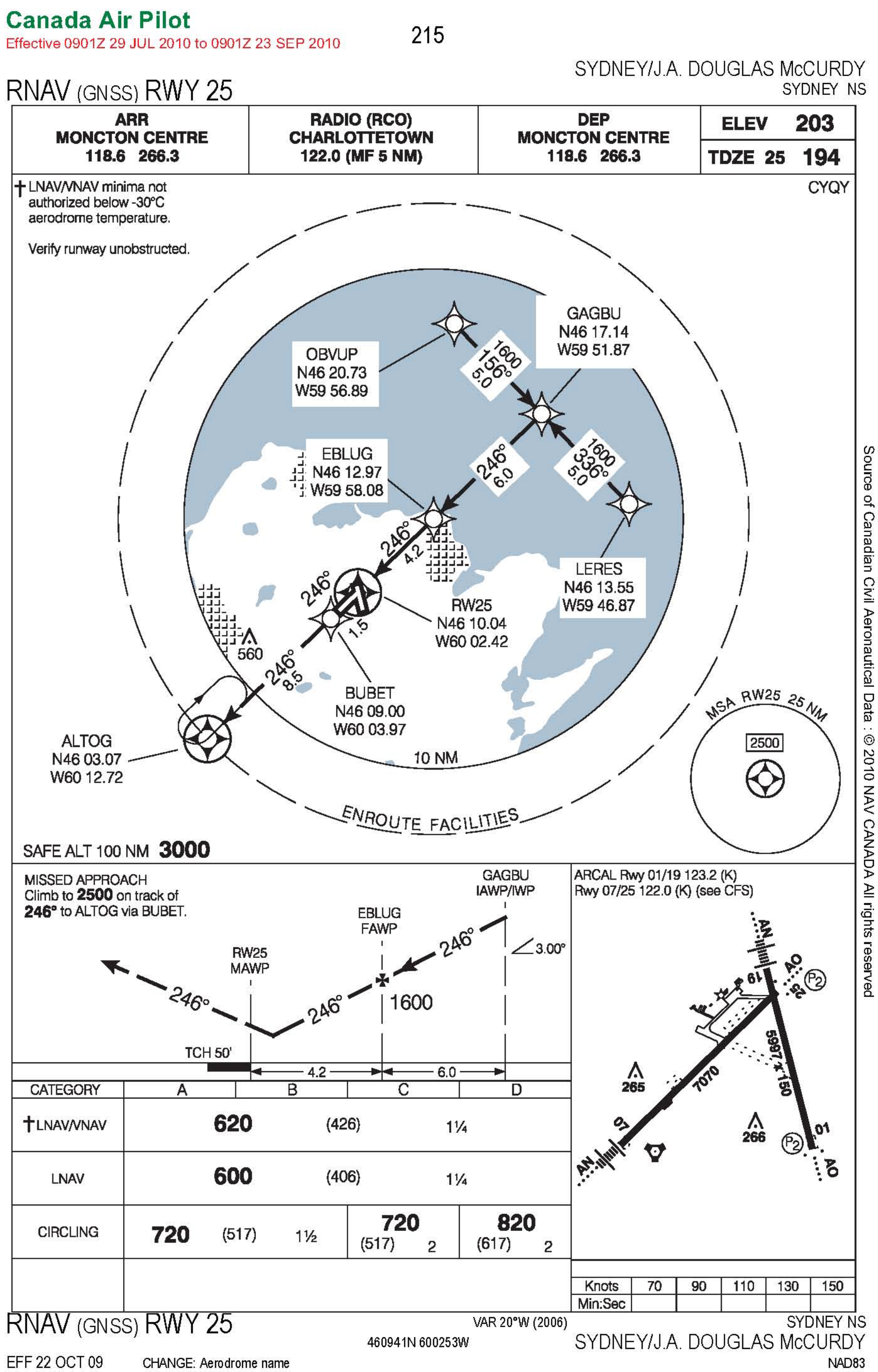
2. The lack of onboard recording devices prevented the investigation from determining the reasons why the aircraft departed controlled flight.

3. The practice of placing aircraft technical records on board aircraft may impede an investigation if the records are lost due to an accident.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 23 June 2011.

Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A – RNAV Runway 25 Approach



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